MICROSTRUCTURAL GROWTH INCREMENTS IN SOME ANTARCTIC FISH OTOLITHS [1]

by

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ABSTRACT. – Otoliths from *Champsocephalus gunnari, Aethotaxis mitopteryx, Notothenia gibberifrons, N. larseni* and *N. rossii* were examined microscopically using acetate peel replicas and the scanning electron microscope. Microstructural growth increments were observed in the otoliths of each species and the possibility of cyclic periodicities of these microincrements in some species is discussed.

RÉSUMÉ. – Des otolithes de *Champsocephalus gunnari, Aethotaxis mitopteryx, Notothenia gibberifrons, N. larseni* et *N. rossii* ont été examinés au microscope électronique à balayage et au microscope optique à partir d'empreintes sur film d'acétate. Des micro-accroissements ont été observés sur les otolithes de chaques espèce et l'auteur discute l'éventuelle périodicité cyclique de ces structures chez certaines espèces.

INTRODUCTION

Periodic growth marks have been reported in the structural hard parts of animals representing several phyla. Pannella and MacClintock (1968) reported on daily growth increments in the shell of the bivalve mollusc *Mercenaria mercenaria* in which fortnightly, monthly and annual patterns of daily increments were discerned. Superimposed on these sequences were checks in the growth patterns which were ascribed to behavioral and environmental perturbations. Pannella (1971, 1974) observed similar daily growth increments in the otoliths of several species of temperate and tropical adult fishes. These increments were similar in microstructure to those of molluscan shells, and annual, monthly and fortnightly patterns were also observed. He reported that the daily growth increments consisted of alternating layers of calcium carbonate-rich material (aragonite, deposited during fast growth periods) and organic-rich material (deposited during slow growth periods). He observed that the periodic sequences of the daily increments consisted of areas where the increments were relatively thick alternating with areas of thin, less sharply defined

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increments. The annual sequences averaged 360 increments. In temperate species a narrow area of thicker increments separated the spawning zones and the annual winter slow growth zones. These short term, or daily, growth increments have since been used in studying the age and growth of the larvae of several tropical and temperate fish species (Brothers et al. 1976 ; Ralston 1977 ; Struhsaker and Uchiyama 1976 ; Taubert and Coble, 1977 ; Barkman 1978 ; and Townsend and Graham, MS).

In addition to ageing larval and juvenile fishes, the basic time units recorded in otoliths by such increments and sequences of increments also make it possible to: 1) distinguish annual markings from other growth checks, 2) eliminate the ambiguity in interpreting the nucleus and first annual growth ring, and 3) study environmental perturbations which may be reflected as checks in the otoliths. Such problems are common in ageing Antarctic fishes and, until now, microstructural growth increments have not been reported in otoliths from these species. This paper presents evidence of such increments in otoliths from a few selected Antarctic fish species.

MATERIALS AND METHODS

The otoliths used in this study were collected by the University of Maine Antarctic Biological Research Program on Cruise 0575, R/V *Islas Orcadas* (USNS *Eltanin*), to the South Sandwich Islands and South Georgia. Otoliths from the following species were examined (total lengths are given in parentheses) : *Champsocephalus gunnari* (9.9 cm), *Aethotaxis mitopteryx* (16.5 cm), *(Notothenia gibberifrons* (7.7 cm), *N. larseni* (20.5 cm), and *N. rossii* (34.5 cm). The otoliths were removed from freshly caught fish and stored dry in glass vials.

The otoliths were prepared for acetate peel replicas and for viewing with the scanning electron microscope. Each otolith was embedded whole in epoxy, ground on a rotating grinding wheel to the vertical mid-saggital plane with 400 and 800 grit aluminium oxide, and polished with 0.05 micron gamma alumina. Each otolith was then etched for 4 to 5 minutes with 0.1 M HCl. The acetate peel replicas were made by placing a single drop of acetone on a sheet of thin cellulose acetate. The acetone was allowed to evaporate for about 10 seconds ; the etched surface of the otolith was then pressed firmly onto the softened acetate sheet. After about 30 minutes drying time the acetate sheet was peeled off the otolith and the replica secured to a microscope slide by taping a coverslip over it. The replicas were examined with transmitted light under a compound microscope. After the acetate peel replicas were made, the same otoliths were secured metal stubs with double stick tape and conductive paint, coated with gold-palladium alloy for 2 minutes in a sputter coater, and examined with the scanning electron microscope.

RESULTS AND DISCUSSION

The otoliths from each of the five species examined showed microstructural growth increments, or microincrements, which were discernible using both techniques : the acetate peel replicas and the scanning electron microscope. The incre-

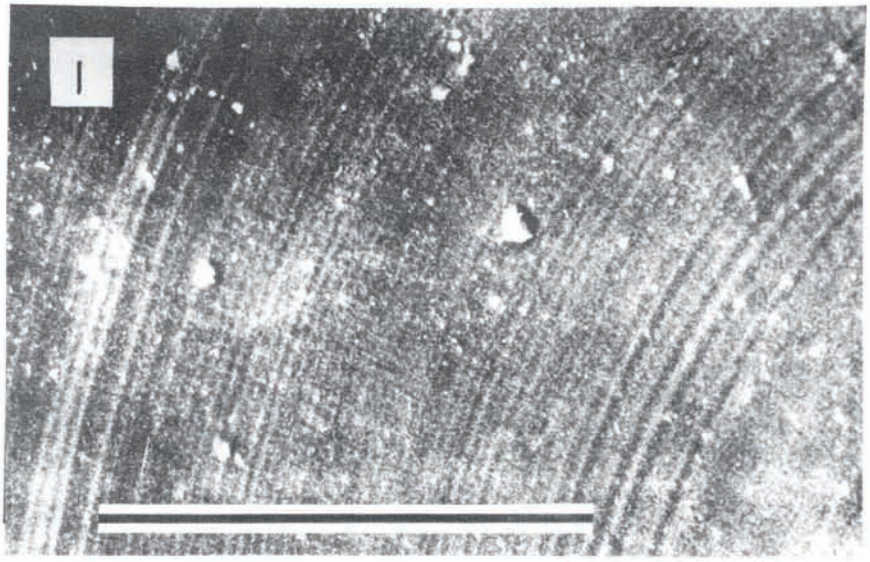

Fig. 1. – Scanning electron micrograph of a ground, polished and etched otolith from *Aethotaxis mitopteryx* (16.5 cm T.L.). Initial magnification = 500X ; Bar = 100 microns.

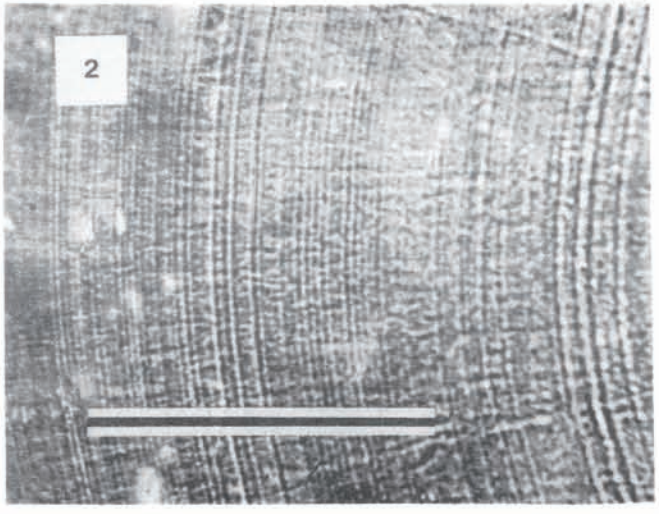

Fig. 2. – Acetate peel replica of otolith in Fig. 1, *A. mitopteryx*. Initial magnification = 500X ; Bar = 100 microns.

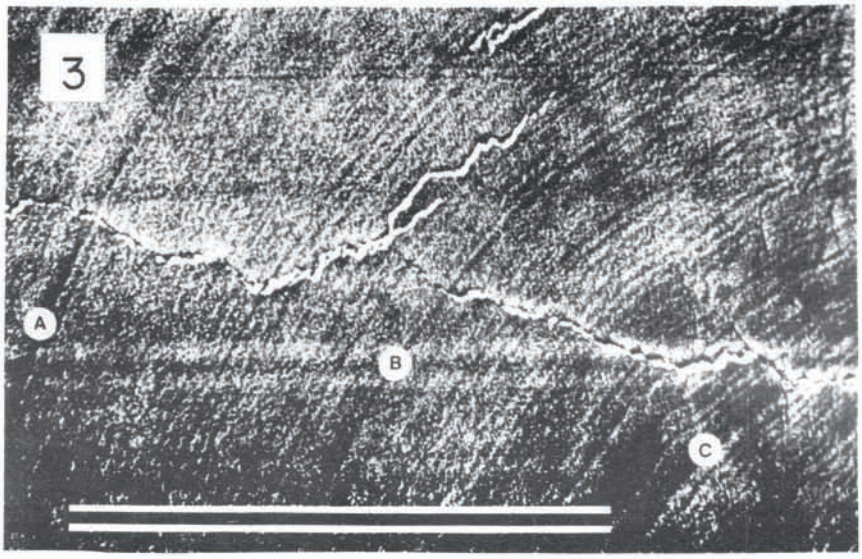

Fig. 3. – Scanning electron micrograph of a ground, polished and etched otolith from *Notothenia larseni* (20.5 cm T.L.). Letters A, B, and C indicate possible lunar sequence marks. Initial magnification = 510X ; Bar = 100 microns.

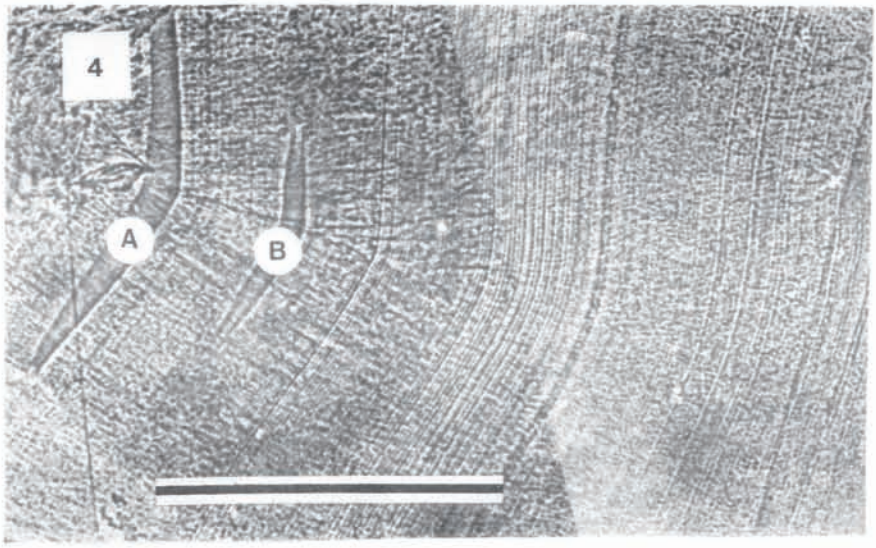

Fig. 4. – Acetate peel replica of otolith in Fig. 3, *N. larseni*, from a different location on the otolith. Possible lunar sequences of microincrements are evident as are anomalous growth zones (labeled A and B). Initial magnification = 500X ; Bar = 100 microns.

ments were visible in the acetate peel replicas as alternating light and dark concentric bands when examined under a compound microscope with transmitted light. They were evident as alternating high and low surface relief when viewed with the scanning electron microscope (Fig. 1-4). The appearance of these features resulted from the differential dissolution of the calcium carbonate-rich material which alternates with organic-rich material. These two layers (termed a couplet) constitute a microincrement, each of which was generally on the order of 1 to 3 microns thick. These microincrements are similar in structure and size to those described by Pannella (1971, 1974). The microincrements were not consistently uniform for each species with respect to increment thicknesses and periodic sequences, however.

The microincrements in the otoliths of *N. gibberifrons* and *C. gunnari* were generally thick, varying from 2 to 10 microns. These increments were variable in clarity, difficult to count, and showed no regular sequential patterns or spacings.

The microincrements in *N. rossii* were not as variable in thickness as the previous two species but were interrupted frequently by a thick increment, about 4 to 5 microns, which produced sequences of no particular periodic pattern.

Aethotaxis mitopteryx and *N. larseni* had the most clearly resolved microincrements of the species examined. The increments in *A. mitopteryx* (Fig. 1 and 2) were easily ccunted over the greater part of the polished surface of the otolith, although no periodically recurring sequences were obvious. *N. larseni* also showed clear microincrements (Fig. 3 and 4). In addition, this species showed periodic patterns consisting of 26 to 30 regularly spaced microincrements followed by an abrupt interruption of growth, apparently the result of a break in the structural continuity of the aragonitic crystals (Pannella, 1974). These sequences of microincrements seemed to persist throughout much of the otolith (Fig. 3 and 4), the exception being in areas where there appeared to be anomalous material in the otolith (Fig. 4).

CONCLUSIONS

These results show that otoliths from Antarctic fishes do exhibit microincremental growth which may be expressed in periodic sequences in some species. It is quite possible, given the size of these microincrements, that they represent daily growth patterns similar to those observed by Pannella (1971, 1974) and that some species, such as *N. larseni*, may show lunar patterns. If it can be demonstrated that such observed structures occur with cyclic periodicities then it would be possible to utilize these time units to study the age and growth of larval and juvenile Antarctic fishes and to interpret growth checks and « annual » growth zones in adult otoliths.

Acknowledgements

I would like to thank Dr. Hugh H. DeWitt for supplying the otoliths used in this study, and Ms. Phyllis Coggins and Dr. Richard A. Lutz for reviewing the manuscript.

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